Fermilab-TM-2744-AD

Front shielding of the 25-kW beam absorber in Linac-to-Booster transfer line

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September 2, 2020

The 25-kW beam absorber in the Linac-to-Booster transfer line is supposed to take in the beam from PIP-II 800-MeV Linac occasionally, on the average for one hour once a week. Such an operational scenario suggests that residual dose of the absorber front part can be relatively low. In order to simplify access to the front part of the absorber and beam window in case of repair or maintenance, using a slide-in shielding plug is considered as a preferred option (see Fig. 1).

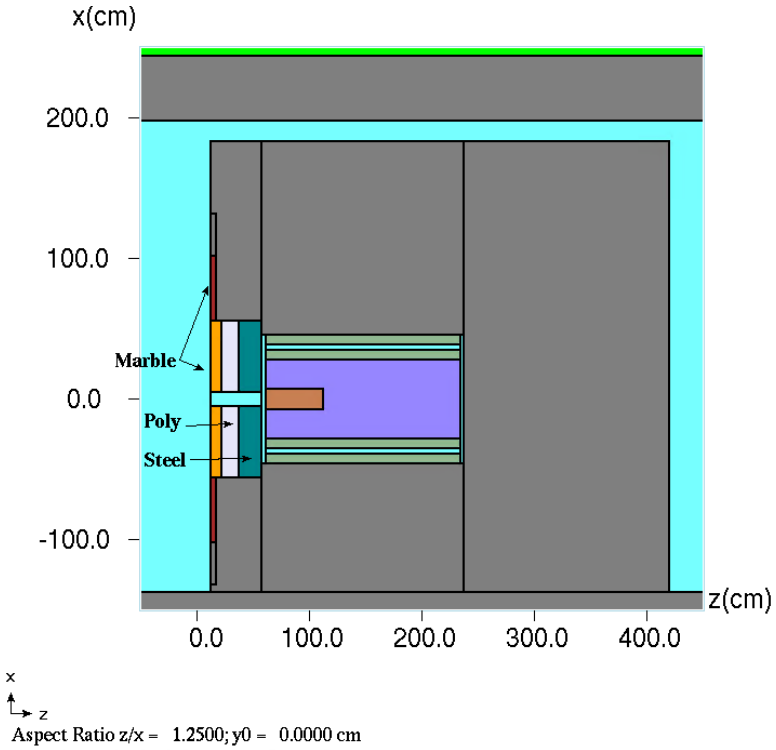

Fig. 1. Elevation view of the 25-kW beam absorber in the Linac-to-Booster transfer line. The slide-in shielding plug is a rectangular volume and consists of steel, polyethylene and marble (8", 6" and 4", respectively). In the plane transverse to the beam, the plug measures 44" in both X and Y direction. An additional layer of marble 2" in thickness is attached to the permanent concrete shielding outside the plug.

Calculations of contact redidual dose on front part of the absorber have been performed with MARS15 [1-2] and DeTra [3] codes. The following non-uniform irradiation scenario has been used: 14 identical cycles for 98 days. Each cycle consists of a 1-hr irradiation with subsequent cooling for 6 days and 23 hours. After the last cooling cycle, one assumes a 1-hr irradiation and 4-hr cooling. The residual doses have been calculated immediately after the last 4-hr cooling. Such a scenario practically corresponds to the widely used concept of a "100-day irradiation and 4-hr cooling" irradiation scenario. The calculated contact residual doses are shown in Fig. 2.

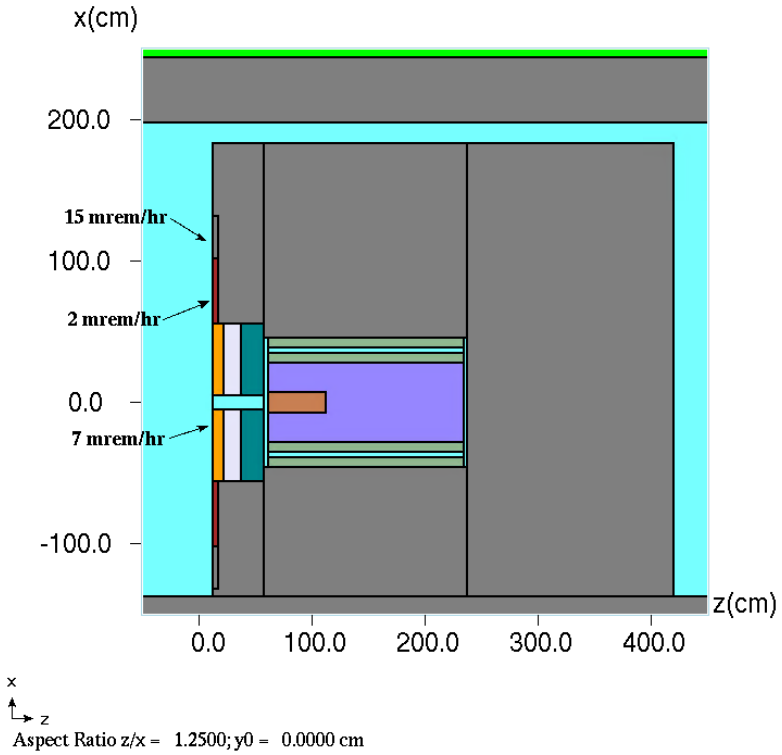

Fig. 2. The calculated contact residual dose on the front part of the absorber. Each shown number corresponds to the dose averaged over the volume denoted with the corresponding arrow.

One should take into account that there can be deviations from the "averaged" irradiation scenario described above. For example, the irradiation time can be 2 or 3 hours instead of the above-mentioned 1 hour. Also, it should be mentioned that the additional 2" thick marble layer is justified by the following fact: without the extra marble the predicted residual dose of concrete in the same place amounts to approximately 100 mrem/hr.

References

[1] N. V. Mokhov, "The MARS Code System User's Guide, Version 15 (2018)", Fermilab-FN-1058-APC (2018); https://mars.fnal.gov/

[2] N. V. Mokhov *et al.*, "MARS15 code developments driven by the intensity frontier needs," Progress in Nuclear Science and Technology, **v.4**, 496 (2014).

[3] P. Aarnio, "Decay and Transmutation of Nuclides," CMS Note 1998/086, CERN, Geneva, Switzerland (1998).